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Effects of years on farınograph parameters and qualıty characterıstıcs

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This study was conducted to determine the farinograph parameters and some quality characteristics of 15 bread wheat varieties grown in rainfed conditions in 2011-2012, 2012-2013 and 2013-2014 according to a randomized block trial design with two replication. The farinograph parameters (development time, water absorption, stabilsity and softening at the 12th minute), protein ratio, grain hardness, Zeleny sedimentation and bread volume of bread wheat varieties were investigated. Three-year average value ranges of quality traits; protein ratio 13.51-16.02%, grain hardness PSI 45.74-71.05, Zeleny sedimentation 34.67-63.67 ml, bread volume 340-519.17 cm^3, farinograph development time 3.75-12.30 min., farinograph water absorption 57.43-65.72%, farinograph stability 4.62-16.92 min. and the farinograph 12 min. softening value 38.66-132.33% was determined as. Significant quality differences were determined between varieties and years, and the highest values in terms of quality traits were obtained in 2013-2014. High values were obtained in Konya-2002, Tosunbey, Karahan-99 and Eraybey varieties in terms of farinograph development time, water absorption and stability values.
Keywords: Bread wheat, farinograph, bread volume, quality, rainfed conditions.

INTRODUCTION

Wheat has been the most developed grain type since the past, and it is also cultivated today. Although there has been a serious increase in grain yield in recent years with the development of new varieties from the past to the present as a result of breeding studies, it is estimated that the grain yield of the wheat plant which constitutes the basic food of 1.2 billion people with low income in the world due to climate change, will decrease by 20-30% by 2050. (Anonymous, 2015). Changes in the climate affect grain quality significantly as well as yield. In addition to high-yielding genotypes, breeding studies continue in the world and in our country in order to improve the quality characteristics that are important in nutrition. Our main food source in our country is bread and its derivatives, and 43% of the daily energy need is obtained from cereal and grain products (Pekcan *et al*., 2006). In the 2000s, 48% of daily energy is met from cereal products in the world and it is predicted that this ratio will be 41% in 2050 (Kruse. 2010; Nelson *et al*., 2010). It is known that the variety and the environment are effective in determining the quality performance of wheat. Therefore, it is extremely important to determine the protein ratios and quality of bread wheat varieties that are widely grown. The quality traits of wheat vary depending on the purpose of use, the protein quality as well as the protein ratio is an important trait that determines the purpose of use. The results obtained from physical, chemical and technological measurements developed to determine the quality of wheat give important ideas about the bread quality of wheat (Dıraman *et al*., 2013). Rheological properties of dough from wheat flour are very important both in the kneading and modeling processes, for the production of bread and bakery products. The most important criteria in determining the protein quality is the rheological properties of the dough. Some devices are used to evaluate the development and behavior of dough and they play an important role in determining the flour quality. With the farinograph device, which has an important place in determining dough properties, such as dough development time, water absorption, stability, softening degree are determined. Farinograph parameters provide information about the amount of water that the flour can hold in the industry and bakery sector, as well as determine the suitability of the obtained dough for different usage purposes. Quality trait such as protein ratio, protein quality and grain hardness also affect the flour's water absorption capacity, as well as the development time, stability value and softening degree of the dough. This study was carried out for 3 years in the central

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location of Konya in rainfed conditions to determine the changes in the farinograph parameters and some quality traits (protein ratio, grain hardness, Zeleny sedimentation and bread volume) of 15 bread wheat varieties according to years and varieties.

MATERIALS AND METHODS

This research was carried out with 15 bread wheat varieties in the central location of Bahri Dagdas International Agricultural Research Institute in Konya as 2 replications according to a randomized block design in rainfed conditions of in 2011-2012, 2012-2013 and 2013-2014 growing periods. Altay-2000, Bağcı-2002, Bayraktar-2000, Bezostaya-1, Dağdaş-94, Demir-2000, Eraybey, Gerek-79, Gün-91, Karahan-99, Müfitbey, Sönmez-2001, Tosunbey, Aliağa, Konya -2002 variaties were used in the trial. Sowing was made as 550 seeds / m^2 per square meter, 3.5 kg / da N and 6.9 kg / da P_2O_5 and 4 kg / da N as top fertilizer (7.5 kg / da N in total) were given. During the growing periods, precipitation rates were 306.10 mm in 2011-2012, 305.30 mm in 2012-2013 and 320 mm in 2013-2014. In the research, protein ratio, Zeleny sedimentation, grain hardness, bread volume and farinograph parameters (development time, water absorption, stability and 12. minute softening degree) of the varieties were investigated. Protein ratio was determined by LECO FP 528 device according to AOAC 992.23 method (Anonymous, 2009) and Zeleny sedimentation value was determined according to AACC 56-61A method (Anonymous, 2000). Hardness PSI (Particle size index) was determined by Near infrared reflection spectroscopy (NIR) device according to AACC 39-10 method (Anonymous, 2000). Wheat samples were annealed according to AACC method 26-95 (14.5% humidity) and ground in Brabender Junnior mill according to AACC method 26-50 (Anonymous, 2000). Farinograph analyzes were performed with the Farinograph-AT Brabender Germany device (Anonymous, 2000) according to the AACC 54-21 method. Evaluation of the data obtained from the trial was made according to the JMP11 statistical analysis program (Anonymous, 2014).

RESULTS AND DISCUSSION

The combined variance analysis results of the quality traits of the included bread wheat genotypes in this study conducted in 2011-2012, 2012-2013 and 2013-2014 are given in (Table 1).

The desired quality traits of wheat may vary depending on the intended use. Protein ratio is the main quality trait, and the protein content and quality of the product to be processed are among the most taken into account criteria. The mean value of protein ratios and grain hardness of the examined bread wheat varieties for the years are given in Table 2. The protein ratio in the wheat grain can vary between 8% and 18%, and this change may vary greatly depending on the variety, climate and soil characteristics. It was determined that the protein ratio of the varieties included in the trial varied between 11.64-15.18 % in 2011-2012, 14.78-16.83 % in 2012-2013 and 14.02-16.68 % in 2013-2014. As a result of variance analysis, the interaction between varieties and between years ($p < 0.01$) and between varieties x years ($p < 0.05$) was found to be significant (Table 1). Although the protein ratio of the grain is genetic, it can change depending on the year conditions. The highest protein ratio among the cultivars was determined in the first and third year in Dağdaş 94 variety (15.18-16.68%) and in the second year in Karahan-99 variety (16.83%). When we evaluate the years separately, the lowest protein ratio was obtained from Aliağa variety (11.64%, 14.78 and 14.12%) with biscuit properties. When evaluated according to three-year averages, a protein ratio value of over 15% was obtained in Dağdaş-94, Altay-2000, Bezostaya-1, Karahan-99, Gün-91 and Tosunbey varieties (Table 2). Aydoğan and Soylu (2016) found in a study they conducted on 14 bread wheat varieties under dry conditions that the protein ratios varied between 11.93-13.44% and the trial average was 12.61%. Grain hardness is an important criterion in bread wheat and it is widely used in the classification of flours in industry. The protein ratio of hard wheat is generally high, and the rate of starch damaged during flour processing is also high. Flours with a high rate of

Table 1. Combined variance analysis results of the quality characteristics of bread wheat varieties for the years 2011-2012, 2012-2013 and 2013-2014.

Variation source	DF	Protein	Hardness (PSI)	Zeleny	B.Volume	FDT	FWA	FSTB	F12DS
Variety (V)	14	26.25**	5070.85**	795.28**	387598.3**	836.18**	419.10**	1352.56**	132.53**
Conditions (C)	2	106.26**	622.82*	391.08**	11397.6**	157.48**	140.72**	830.66**	83.64**
Recurrence	1	7.11	9.77	19.60	80.3	0.39	2.00	1.41	1.40
V*C	28	30.24*	2179.70*	2775.58*	37170.0**	375.06**	71.76**	603.00**	603.01**
Error	44	17.69	1499.43	278.40	16282.2	19.02	30.50	35.20	35.20

* ($p<0.05$), ** ($p<0.01$), DF: Degrees of freedom, B. Volume: Bread Volume, FDT Farinograph Development Time, FWA: Farinograph Water Absorption, FSTB: Farinograph Stability, F12DS: Farinograph 12. min Softening Value

Table 2. Values of protein content and grain hardness of bread wheat varieties.

	Protein Content (%)				Grain Hardness (PSI)			
Varieties	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**
Aliağa	11.64	14.78	14.12	13.51	61.50	62.41	66.36	63.42
Altay-2000	14.01	15.88	16.07	15.32	70.00	59.25	56.35	61.87
Bağcı-2002	12.66	15.23	16.13	14.67	63.21	55.72	55.50	58.14
Bayraktar-2000	13.62	15.62	14.81	14.68	75.00	65.17	65.05	68.41
Bezostaya-1	14.57	15.49	16.23	15.43	54.11	47.75	55.04	52.30
Dağdaş-94	15.18	16.21	16.68	16.02	38.00	39.99	59.23	45.74
Demir-2000	13.00	15.66	16.29	14.98	59.00	60.15	51.46	56.87
Eraybey	13.73	15.10	14.02	14.28	59.12	61.52	65.60	62.08
Gerek-79	13.10	14.60	15.14	14.95	83.00	65.52	64.63	71.05
Gün-91	13.94	16.04	15.82	15.26	59.32	49.41	56.11	54.95
Karahan-99	14.58	16.83	14.51	15.31	76.00	61.70	58.37	65.36
Konya-2002	13.25	15.96	15.26	14.82	54.00	57.30	54.51	55.27
Müfitbey	13.77	15.99	14.99	14.92	54.50	47.83	49.23	50.52
Sönmez-2001	13.80	15.52	14.90	14.74	51.50	45.83	56.92	51.42
Tosunbey	14.15	16.34	15.88	15.46	55.21	32.52	51.41	46.38
General average	13.67	15.81	15.39	14.95	60.90	54.14	57.72	57.58
$CV_{(\%)}$	4.09	3.07	4.93	4.20	4.41	6.29	3.20	7.10
$LSD_{(0.05)}$	1.19	1.07	1.76	0.72	14.78	7.38	14.64	6.77

damaged starch have more water-lifting capacity during dough processing (Khan and Shewry 2009). Wheats are grouped as hard-red winter (HRW), hard-red summer (HRS), soft-red-winter (SRW) and white (WW). Hard wheat varieties are the most suitable varieties for commercial bakery with their high protein content (10-18% protein) and quality (Türker ve Ertaş, 2002). The hardness values are examined in terms of (PSI) and as the value approaches 100, it expresses the softness. The hardness value (PSI) of the varieties varied between 38.00-83.00 (PSI) in 2011-2012, 32.52-65.52 (PSI) in 2012-2013 and 49.23-66.36 (PSI) in 2013-2014 (Table 2). According to the results of variance analysis, the difference between varieties ($p < 0.01$), and the difference between years and varieties*years ($p < 0.05$) were found to be statistically significant (Table 1). Among the varieties, Dağdaş-94 in the first and second year, and Müfitbey in the third year were in the hardest group According to the three-year averages of the hardness values, Dağdaş-94 and Tosunbey varieties were in the hard group, and Aliağa, Altay-2000, Bayraktar-2000, and Gerek-79 in the medium soft group (Table 2). Aydoğan and Soylu (2016) in a similar study they conducted, determined that the hardness (PSI) value of the varieties varied between 41.27 and 64.82, and the trial average was 50.89. The hardness value can be affected by climatic factors as well as depending on the protein content and quality of the grain.

Zeleny sedimentation value is an important criterion used to determine protein quality in bread wheat. The Zeleny sedimentation value of the varieties varied between 32.50-65.50 ml in 2011-2012, 36.00-64.50 ml in 2012-2013 and 35.00-67.50 ml in 2013-2014 (Table 3). According to the results of variance analysis, the difference between varieties ($p < 0.01$), and the difference between years and varieties*years ($p < 0.05$) were found to be statistically significant. Among the varieties, the highest Zeleny sedimentation value was obtained from Eraybey (65.50 and 67.50 ml) in the first and third year and Karahan-99 (64.50 ml) in the second year. In terms of Zeleny sedimentation value, a low value was taken from Aliağa variety in three years, this variety has medium quality values and is widely used in the biscuit industry. When evaluated according to three-year averages, Zeleny sedimentation value over 50 ml was obtained in Eraybey, Karahan-99 Bezostaya-1, Bağcı-2002, Demir-2000, Gün-91, Müfitbey, Altay-2000, Konya-2002, Sönmez-2001 and Tosunbey varieties. Peterson *et al*. (1992) determined that the variance of environmental effects for quality criteria is greater than the variance of genetic factors. However, Souza *et al*. (2004) reported that the most determining factor of the quality criteria of wheat in both irrigated and rainfed areas is variety. Wheats with high protein ratio and quality are generally medium hard and hard, so high volume breads are obtained by increasing the swelling potential of the dough due to the high water absorption capacity and high gluten quality. Bread volume of varieties varied between 332.50-522.50 cm^3 in 2011-2012, 305-500 cm^3 in 2012-2013 and 367.50-590 cm^3 in 2013-2014 (Table 3). According to the results of variance analysis, the difference between varieties, years and varieties*years ($p < 0.01$) was found to be statistically significant (Table 1). The highest bread volume among the varieties was determined in Eraybey with 522.50 cm^3 in the first year, Bağcı-2002 with 500 cm^3 in the second year and Konya-2002 in the third year with 590 cm^3. When evaluated according to the three-year averages, the highest values in terms of bread volume were obtained in Müfitbey, Tosunbey and Eraybey varieties, and

Table 3. Zeleny sedimentation and bread volume values of bread wheat varieties.

	Zeleny Sedimentation (ml)				Bread Volume (cm^3)			
Varieties	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**
Aliağa	32.50	36.50	35.00	34.67	332.50	317.50	370.00	340.00
Altay-2000	48.00	58.00	57.50	54.50	455.00	410.00	475.00	446.67
Bağcı-2002	54.00	56.00	54.00	54.67	490.00	500.00	510.00	500.00
Bayraktar-2000	35.00	36.00	39.50	36.83	350.00	305.00	395.00	350.00
Bezostaya-1	44.50	62.50	67.00	58.00	515.00	415.00	480.00	470.00
Dağdaş-94	35.00	39.00	35.50	36.50	465.00	370.00	435.00	423.33
Demir-2000	40.00	63.00	64.00	55.67	472.50	462.50	562.50	499.17
Eraybey	65.50	58.00	67.50	63.67	522.50	490.00	540.00	517.00
Gerek-79	38.00	40.00	41.50	39.83	335.00	310.00	367.50	337.50
Gün-91	56.50	48.50	54.00	53.00	505.00	422.50	560.00	495.83
Karahan-99	62.50	64.50	62.00	63.00	502.50	432.50	560.00	498.33
Konya-2002	35.50	60.00	63.50	53.00	470.00	470.00	590.00	510.00
Müfitbey	51.50	47.50	54.00	51.00	515.00	475.00	567.50	519.17
Sönmez-2001	63.00	46.00	43.00	50.67	490.00	465.00	575.00	510.00
Tosunbey	49.50	50.00	55.50	51.00	520.00	460.00	577.50	519.00
General average	47.40	50.85	52.59	50.37	462.67	420.33	504.33	462.40
$CV_{(\%)}$	4.55	5.22	1.82	5.02	5.46	3.25	2.76	4.11
$LSD_{(0.05)}$	5.28	5.60	2.03	2.90	54.20	29.21	29.96	22.20

Table 4. Farinograph development time and farinograph water absorption values of bread wheat varieties.

	Farinograph Development Time (min.)				Farinograph Water Absorption (%)			
Varieties	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**
Aliağa	3.19	3.73	4.35	3.75	58.65	57.98	59.85	58.83
Altay-2000	9.12	3.48	9.24	7.28	59.86	63.47	65.71	63.01
Bağcı-2002	5.74	6.29	7.40	6.48	60.66	63.51	65.50	63.22
Bayraktar-2000	12.17	10.39	12.24	11.60	53.81	59.81	58.68	57.43
Bezostaya-1	14.72	7.18	9.80	10.57	63.80	63.88	64.50	64.06
Dağdaş-94	6.22	3.72	4.49	4.81	64.71	64.71	66.00	65.14
Demir-2000	5.02	3.60	5.11	4.58	62.19	66.06	65.50	64.58
Eraybey	12.84	8.19	12.89	11.30	62.22	62.83	65.20	63.42
Gerek-79	4.29	4.15	3.33	3.92	58.78	59.66	60.00	59.48
Gün-91	12.01	5.23	8.07	8.43	63.50	65.86	66.00	65.12
Karahan-99	17.81	9.03	10.06	12.30	61.60	61.63	63.30	62.18
Konya-2002	6.76	5.64	7.39	6.59	64.60	65.62	66.95	65.72
Müfitbey	10.79	6.16	7.51	8.15	62.50	63.52	64.80	63.61
Sönmez	7.29	4.17	4.27	5.24	64.10	64.66	65.65	64.80
Tosunbey	8.91	11.16	14.87	11.65	61.28	63.96	66.40	63.88
General average	9.12	6.14	8.06	7.77	61.48	63.14	64.27	62.96
$CV_{(\%)}$	1.12	3.44	4.05	7.68	1.27	7.41	1.34	2.63
$LSD_{(0.05)}$	2.14	1.04	0.70	0.74	1.66	1.32	1.84	0.96

the lowest bread volume was obtained in the varieties of Gerek-79, Aliağa and Bayraktar-2000 (Table 3). Peterson *et al.* (1992) reported that the sedimentation value indicates the protein quality and the potential for rising volume of bread.

Rheology; it is a concept that includes the flow and deformation properties of materials. The rheological properties of dough, which is an intermediate product in the transformation of flour into bread or other bakery products, are determined by its composition and structure. (Dobraszczyk and Morgenstern 2003). Farinograph development time of cultivars varied between 3.19-17.81 minutes in 2011-2012, 3.48-11.16 minutes in 2012-2013, and 3.33-14.87 minutes in 2013-2014 (Table 4). According to the results of variance analysis, the difference between varieties, years and varieties*years ($p < 0.01$) was found to be statistically significant. (Table 1). The highest farinograph development time among the cultivars was determined in Karahan-99 (17.81 min.) in the first year, and in Tosunbey

(11.16 and 14.87 min.) in the second and third years. When we evaluate the years separately, the lowest farinograph development time (3.19-3.73-4.35 min.) was obtained in the Aliağa variety. When evaluated according to the averages of three years; farinograph development time over 5 minutes was obtained from Karahan-99, Tosunbey, Eraybey, Bayraktar-2000, Bezostaya-1, Bağcı-2002, Altay-2000, Konya-2002, Demir-2000, Gün-91, Müfitbey and Sönmez-2001 varieties (Table 4). In general, a longer departure time indicates strong flour. Protein ratio, water absorption capacity, gluten ratio and index are the most important traits in the evaluation of flour quality. Increased water absorption capacity of the farinograph provides good gelatinization, oven splash, soft shell structure and low retrogradation. This is why water absorption capacity is such a critical point in bread making (Sluimer, 2005). Farinograph measures the water absorption capacity of the flour, the time and resistance during kneading as well as the softening value of the dough. The water absorption values of the wheat varieties in the trial varied between 53.81% and 66.95% depending on the varieties. It was observed that the farinograph water absorption value of the cultivars varied between 53.81-64.71% in 2011-2012, 57.98-66.06% in 2012-2013 and 58.68-66.95% in 2013-2014 (Table 4). According to the results of variance analysis, the difference between varieties, years and varieties*years ($p < 0.01$) was found to be statistically significant (Table 1). Among the varieties, the highest farinograph water absorption value was determined in the first year Dağdaş-94 (64.71%), the second year Demir-2000 (66.06%) and the third year Konya-2002 (66.95%). According to the years, the lowest farinograph water absorption values were obtained in Bayraktar-99 (53.81%-58.68%) in the first and third years, and in Aliağa (57.98%) in the second year. According to the mean value of three years, the highest farinograph water absorption value was determined in Konya-2002 variety (Table 4). There have been significant differences in farinograph water absorption value over the years, and these differences are influenced by variety and climate factors.

Farinograph stability value is defined as the dough remaining above the 500 consistency line for a certain period of time without losing any of its properties during kneading. Depending on the protein ratio and quality, kneader pallets show resistance for a long or short time. Flours with long stability times are generally more suited for hearth or variety bread production and often require longer mixing times. In this study, farinograph stability values showed a wide variation with the effect of variety and years. Farinograph stability value was 3.73-19.50 minutes in 2011-2012, 2.92-17.50 minutes in 2012-2013, and 4.01-17.50 minutes in 2013-2014 ranged between (Table 5). According to the results of variance analysis, the difference between varieties, years and varieties*years ($p < 0.01$) was found to be statistically significant (Table 1). The highest farinograph stability value was obtained in first year Bağcı-2002 (19.50 minutes), second and third year Tosunbey (17.50 minutes). The lowest farinograph stability value was obtained in Aliağa in the first year, in Altay-2000 in the second year and in Dağdaş-94 in the third year. When evaluated according to the average of three years, Tosunbey, Eraybey, Bayraktar-99, Bağcı-2002, Karahan-99, Müfitbey, Gün-91, Altay-2000, Bezostaya-1, Konya-2002 and Sönmez-2001 varieties with a farinograph

Table 5. Farinograph stability and 12. min softening values of bread wheat varieties.

	Farinograph Stability (min.)				Farinograph 12 min. Softening (%)			
Varieties	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**	**2011-2012**	**2012-2013**	**2013-2014**	**Mean**
Aliağa	3.73	5.20	4.93	4.62	112.00	157.50	127.50	132.33
Altay-2000	13.95	2.92	10.43	9.10	35.00	75.00	90.00	66.66
Bağcı-2002	19.50	7.06	6.18	10.91	35.00	65.00	97.50	65.83
Bayraktar-2000	15.50	9.50	14.5	13.16	49.00	59.50	69.00	59.16
Bezostaya-1	16.50	8.51	12.39	12.13	19.00	66.00	73.50	52.83
Dağdaş-94	9.14	6.40	4.30	6.61	69.50	85.00	132.50	95.66
Demir-2000	7.14	4.38	7.12	6.21	47.50	85.00	64.50	65.66
Eraybey	17.50	10.24	17.45	15.08	42.00	82.00	41.50	55.16
Gerek-79	10.81	4.56	4.01	6.46	56.00	132.5	106.50	98.33
Gün-91	17.00	3.33	6.90	9.08	63.50	65.00	47.50	58.67
Karahan-99	16.50	9.48	6.40	10.79	62.50	25.00	33.00	40.16
Konya-2002	9.03	6.57	9.31	8.30	39.50	65.00	50.50	51.66
Müfitbey	17.50	6.32	9.45	11.09	58.00	63.00	55.50	58.83
Sönmez-2001	17.50	3.66	4.45	8.54	11.50	105.00	63.50	60.00
Tosunbey	15.76	17.50	17.50	16.92	29.50	26.50	60.00	38.66
General average	13.80	7.04	9.01	9.93	45.97	75.8	72.03	64.59
$CV_{(\%)}$	4.17	7.68	3.93	7.90	9.72	3.81	4.16	5.71
$LSD_{(0.05)}$	3.06	1.11	0.77	1.02	10.78	8.64	5.32	4.65

Table 6. Correlation coefficients between examined traits.

Variable	The dependent variable	Correlation
Grain Hardness	Protein Ratio	0.4967*
Zeleny Sedimentation	Protein Ratio	0.6437*
Bread Volume	Grain Hardness	0.2524*
Bread Volume	Zeleny Sedimentation	0.3910**
Farinograph Development Time	Protein Ratio	0.5838*
Farinograph Development Time	Grain Hardness	0.2159*
Farinograph Development Time	Zeleny Sedimentation	0.5495*
Farinograph Development Time	Bread Volume	0.5716*
Farinograph Water Absorption	Protein Ratio	0.4957**
Farinograph Water Absorption	Grain Hardness	0.5150**
Farinograph Water Absorption	Zeleny Sedimentation	0.5537*
Farinograph Water Absorption	Bread Volume	0.6833**
Farinograph Stability Value	Protein Ratio	0.4596**
Farinograph Stability Value	Farinograph Development Time	0.7977**
Farinograph Stability Value	Farinograph Water Absorption	0.3278*
Farinograph 12 min Softening Value	Zeleny Sedimentation	-0.2578*
Farinograph 12 min Softening Value	Bread Volume	-0.3793*
Farinograph 12 min Softening Value	Farinograph Development Time	-0.5814**
Farinograph 12 min Softening Value	Farinograph Stability Value	-0.7015**

stability value above 7% has been (Table 5). The degree of softening is defined as the resistance of the dough to the kneading pallets during kneading. As the gluten quality increases, the resistance to the pallets increases and the degree of softening decreases accordingly. The farinograph 12.min softening value of the varieties in 2011-2012 varied between 11.50-112.00 BU, 25-157.50 BU in 2012-2013 and 33.00-132.50 BU in 2013-2014 (Table 5). According to the results of variance analysis, the difference between varieties, years and varieties*years ($p < 0.01$) was found to be statistically significant (Table 1). The lowest farinograph 12. min. softening value among the varieties was determined in Sönmez-2001 in the first and third year and in Karahan-99 in the second year. The highest farinograph 12. min. softening value was determined in Aliağa in the first and second year and Dağdaş-94 in the third year. According to the average of three years, the lowest farinograph 12. minute softening value was obtained from Tosunbey variety (Table 5). It was determined that the stability value was high in 2011-2012 and the softening value was low in the same year, a negative significant relationship was found between stability and softening value (-0.7015 **) in the correlation analysis (Table 6).

According to the correlation coefficients of the examined traits with grain hardness; significant positive associations were determined between protein ratio (0.4967*), bread volume (0.2524*), farinograph development time (0.2159*) and farinograph water absorption (0.5150**). Protein ratio and quality increased with the increase in hardness values. By Zeleny sedimentation; significant positive correlation was determined between protein ratio (0.6437*), bread volume (0.3910**), farinograph development time (0.5495*), farinograph water absorption (0.5537*). A significant negative correlation was determined between Zeleny and farinograph 12. min softening value (-0.2578**). Significant positive correlation between the bread volume and farinograph development time (0.5716*) and farinograph water absorption (0.6833**) was determined. A significant negative correlation with farinograph 12. min softening value (-0.3793*) was determined. Significant positive correlations were found between farinograph development time and protein ratio (0.5838*), and farinograph stability (0.7977**). Significant negative correlation (-0.5814**) was determined between farinograph development time and farinograph 12. min softening value. Significant positive correlation was determined between farinograph stability and farinograph water absorption (0.3278*) and protein ratio (0.4596**). Significant negative correlation was determined between farinograph stability value and farinograph 12 min softening value (-0.7015**) (Table 6). Aydogan *et al*., (2013) in a study in which they examined the farinograph properties of 21 bread wheat varieties under dry conditions, a positive significant correlation was found between the development time and the hardness value and Zeleny sedimentation (0.378*, 0.403**). They found significant positive correlations between farinograph water absorption and protein ratio and Zeleny sedimentation (0.403**, 0.389*). Şahin *et al*., (2013) in a study with bread wheat, determined a positive significant correlation between bread volume and farinograph water absorption (0.518**) and Zeleny sedimentation value (0.297**).

DISCUSSION

In this study, the effects of variety and year factors on farinograph parameters and some quality traits and the differences that may occur were tried to be determined. Dough kneading is one of the most important ways to characterize the quality of wheat flour samples. In the 2011-2012 growing season, the mean values of farinograph development time and stability were found to be high, while the 12. min softening value was low. The lowest grain hardness value was determined in the 2012-2013 growing season and the varieties were in the medium hard and hard group. Protein ratio, Zeleny sedimentation, bread volume and farinograph water absorption values were high in 2013-2014 growing season. Environmental and genotypic interactions on show differences in yield and quality parameters of wheat. According to the three-year means of the varieties included in the trial, high values were obtained from Dağdaş-94 and Tosunbey varieties in terms of protein content and grain hardness. Eraybey and Karahan-99 in terms of Zeleny sedimentation, Müfitbey, Tosunbey and Eraybey in terms of bread volume, Eraybey and Tosunbey in terms of farinograph stability value, Dağdaş-94, Konya-2002 and Gün-91 varieties in terms of farinograph water absorption stood out with high values. Low values were obtained in terms of farinograph 12. minute softening value in Tosunbey, Karahan-99 and Eraybey varieties. High correlation values were obtained between the examined farinograph parameters and their quality traits. Significant positive corelations were determined between protein ratio and grain hardness, Zeleny sedimentation, water absorption and stability. Significant positive corelations were determined between farinograph development time and water absorption, Zeleny sedimentation, bread volume and grain hardness. It is important that the quality traits of varieties can be determined by studies conducted for many years, and that similar studies continue in the following years.

Conclusion: In this study, the effects of variety and year factors on farinograph parameters and some quality traits and the differences that may occur were tried to be determined. Dough kneading is one of the most important ways to characterize the quality of wheat flour samples. In the 2011-2012 growing season, the mean values of farinograph development time and stability were found to be high, while the 12. min softening value was low. The lowest grain hardness value was determined in the 2012-2013 growing season and the varieties were in the medium hard and hard group. Protein ratio, Zeleny sedimentation, bread volume and farinograph water absorption values were high in 2013-2014 growing season. Environmental and genotypic interactions on show differences in yield and quality parameters of wheat. According to the three-year means of the varieties included in the trial, high values were obtained from Dağdaş-94 and Tosunbey varieties in terms of protein content and grain hardness. Eraybey and Karahan-99 in terms of Zeleny sedimentation, Müfitbey, Tosunbey and Eraybey in terms of bread volume, Eraybey and Tosunbey in terms of farinograph stability value, Dağdaş-94, Konya-2002 and Gün-91 varieties in terms of farinograph water absorption stood out with high values. Low values were obtained in terms of farinograph 12. minute softening value in Tosunbey, Karahan-99 and Eraybey varieties. High correlation values were obtained between the examined farinograph parameters and their quality traits. Significant positive corelations were determined between protein ratio and grain hardness, Zeleny sedimentation, water absorption and stability. Significant positive corelations were determined between farinograph development time and water absorption, Zeleny sedimentation, bread volume and grain hardness. It is important that the quality traits of varieties can be determined by studies conducted for many years, and that similar studies continue in the following years.

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